PATENT SPECIFICATION

753,164

Date of Application and filing Complete Specification: March 30, 1954.

No. 9359/54.

Complete Specification Published: July 18, 1956.

Index at acceptance:—Classes 2(5), R1A, R1C(4:6:8:11); and 83(1), F(6BX:13BX).

COMPLETE SPECIFICATION

Improvements in or relating to Coated Particles of Sand and method of Coating same

[redacted] ALEXANDER

SPECIFICATION NO. 753,164

The following incorporates a correction in accordance with the Decision of the Assistant Comptroller acting for the Comptroller-General dated the thirtieth day of October, 1956, amendments under Section 29 in accordance with the Decisions of the Superintending Examiner acting for the Comptroller-General dated the twentieth day of July, 1960 and the 15th day of April, 1965.

Page 1, line 1, *for* "Beauvois" *read* "Beauvais"

Page 1, line 4, *for* "Rudolf" *read* "Rodolf"

Page 3, line 95, *after* "material" *delete* full stop *insert* ", the waxy material being present in an amount of 0.5 to 15% by weight of the resin".

Page 3, line 123, *delete* "a" *insert* "in the Mixture from 0.5 to 15% based on the weight of the resin of a normally solid waxy material".

Page 3, *delete* line "124".

Page 3, lines 127 and 128, *delete* is in the amount of 0.3 to 15% by weight of the sand and"

THE PATENT OFFICE,
1st June, 1965

D 40221/3

minute the resin melts and fuses and forms a

The "shell molding" process for the production of sand mold sections for the casting of metals as previously known has in general comprised the employment of an essentially dry mixture of sand and powdered resin and when required powdered resin curing and accelerating agents, and the depositing of such mixture against the face of a heated metal pattern coated with a lubricating or release agent such as silicone resin. This is generally accomplished by placing the aforesaid dry mixture in the bottom of a pivotally supported or other container with the top closed by the metallic pattern. After the pattern is preheated to about 400—500° F., the container is inverted so that the sand-resin mixture is thrown against it, and in less than a

[Pr[illegible]

bining with or building into the resin coated sand a waxy material which provides several advantages.

One advantage of the present invention is that the incorporated waxy material acts as a built-in lubricant or release agent when the coated sand is applied to a metal pattern in producing shell molds.

Another advantage is that shell molds of improved strength and greater density can be obtained resulting in greater resistance to hot metal penetration and higher fidelity of casting surfaces.

Another advantage is the reduction in tendency of the preliminary shell or crust to fall off the pattern prematurely when invert-

P[illegible]

PATENT SPECIFICATION

753,164

Date of Application and filing Complete Specification: March 30, 1954.

No. 9359/54.

Complete Specification Published: July 18, 1956.

Index at acceptance:—**Classes 2(5)**, R1A, R1C(4:6:8:11); **and 83(1)**, F(6BX:13BX).

COMPLETE SPECIFICATION

Improvements in or relating to Coated Particles of Sand and method of Coating same

We, DONALD BEAUVOIS ALEXANDER, HENRY THOMAS CHAMBERLAIN, JOHN FRANCIS MANNION, WALTER AHERN WADE, EDGAR RUDOLF BOURKE, ERNEST WARREN SCHNEIDER, CHARLES STANLEY VRTIS, and LEE JOSEPH GARY, all citizens of the United States of America, all of 1830, South 54th Avenue, City of Chicago, State of Illinois, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to improvements in the production of sand precoated with resin and particularly adapted for use in the "shell molding" process.

More particularly, the present invention relates to improvements in the method of producing storage-stable, substantially free-flowing sand particles whereby each sand grain is provided with a solid, non-tacky enveloping coating of potentially thermosetting phenolic resin composition and an outermost coating of solid, non-tacky, waxy material such as a natural or synthetic wax, and to the novel properties, utility and advantages of the resulting product.

The "shell molding" process for the production of sand mold sections for the casting of metals as previously known has in general comprised the employment of an essentially dry mixture of sand and powdered resin and when required powdered resin curing and accelerating agents, and the depositing of such mixture against the face of a heated metal pattern coated with a lubricating or release agent such as silicone resin. This is generally accomplished by placing the aforesaid dry mixture in the bottom of a pivotally supported or other container with the top closed by the metallic pattern. After the pattern is preheated to about 400—500° F., the container is inverted so that the sand-resin mixture is thrown against it, and in less than a minute the resin melts and fuses and forms a unitary crust of from about $\frac{1}{8}$ to about $\frac{1}{2}$ inches in thickness. Excess sand-resin mixture, which has not been reached by heat in an amount to fuse the resin, is removed for subsequent use, and the preliminary shell or crust on the pattern is subjected to further heat, as in an oven, to cure the resin to the thermoset or infusible condition. It is then separated from the pattern in the form of a rigid shell mold section ready for use for the casting of metals.

As distinguished from the employment of dry sand-resin mixtures in the aforesaid process, applicant's copending application No. 9358/54 (Serial No. 753,163) teaches the production of storage-stable, free-flowing sand grains, each provided with a solid non-tacky coating of potentially thermosetting phenolic resin for use in the aforesaid shell molding process in lieu of the dry sand-resin mixture. This eliminates dust and explosion hazards of a powdered mix, avoids separation and stratification of the components, permits employment of conventional foundry sand handling equipment, permits the production of shell molds of more uniform character and of improved physical properties, and saving in the amount of resin required.

The present invention provides a further improvement which is accomplished by combining with or building into the resin coated sand a waxy material which provides several advantages.

One advantage of the present invention is that the incorporated waxy material acts as a built-in lubricant or release agent when the coated sand is applied to a metal pattern in producing shell molds.

Another advantage is that shell molds of improved strength and greater density can be obtained resulting in greater resistance to hot metal penetration and higher fidelity of casting surfaces.

Another advantage is the reduction in tendency of the preliminary shell or crust to fall off the pattern prematurely when invert-

[Pr

ing the dump box to remove excess sand, or splitting of the preliminary shell, or sticking of hot plastic sand to the rim of the dump box above the metal pattern.

Further advantages arising out of the use of the waxy additive in the process of coating the sand with the resin are the economies and facility of the mixing and coating process, such as great reduction in power consumption for a given quantity of sand being handled in a mixer or ability to handle much larger quantities of sand for the same power consumption, all with saving in wear and breakdown of mixing equipment.

A further advantage is that the addition of the waxy material makes possible the coating of the sand with liquid thermosetting or potentially thermosetting resin in the cold as well as in the hot process of our previously mentioned copending application. The reason for this is that the waxy material practically eliminates all tackiness of the resin coated sand which might be the case if the waxy material were not added, since in the cold process the resin does not become advanced to as great a degree as in the hot process.

Suitable additives are waxes or wax-like materials which are normally solid, such as microcrystalline or other paraffin waxes; synthetic waxes such as a substituted polyamide of stearic acid known as "Acrawax C": waxy medium molecular weight polyethylenes; methylene bis-stearamide; and materials such as calcium, lithium and zinc stearates. These may be employed in amounts as low as 0.5% by weight of the resin in the case of the harder waxes and when using the hot process, and up to 15% with the softer waxes and when using the cold coating process. The amount added is also related to some extent to the type of sand used, the type and percent of resin used, and the desired character of the end product. Thus the higher amounts of waxy material of relatively softer character may be employed to provide some "clumping" tendency which is desirable in handling the coated sand by blowing, instead of using dump boxes, for application to the metal pattern in forming shell molds. The harder waxy materials may be added in powdered form and the softer ones either as pastes or solutions for the purpose of obtaining good mixing and coating, and they may be added any time during the mixing while the resin is in liquid condition, and desirably added in several parts. For example, a portion may be promptly added at the beginning of the mixing operation and another portion at a later time.

The resins employed are phenol-formaldehyde resins of potentially thermosetting or thermosetting character. Thus we may employ resins of the two-stage or "novolak" type which are formed from 0.5 to 0.9 mols of formaldehyde per mol of phenol and which remain thermoplastic until combined with added aldehyde such as 8—20% by weight of hexamethylenetetramine, whereupon the resin becomes potentially thermosetting, and can be subsequently thermoset by heat. These are further of two kinds: One is a normally liquid resin formed from about 0.5—0.725 mols of formaldehyde and has a resin solids content of 70—80% as disclosed in copending application No. 9357/54 (Serial No. 753,162), and may be employed for the present invention, together with hexamethylenetetramine and the waxy additive in the hot or cold method, and is the preferred resin. The other is a normally solid resin formed from about 0.75—0.9 mols of formaldehyde per mol of phenol, and likewise may be employed for the present invention together with hexamethylenetetramine and the unctuous additive in either the hot or cold method, except that in the cold method this solid resin is first dissolved in a solvent such as an equal part of ethanol. In the alternative, a liquid one-stage phenol-formaldehyde resin of thermosetting character, and which does not require any added aldehyde may be employed in the cold process, together with the unctuous additive, such resin being prepared from at least equimolar proportions of a phenol and an aldehyde or with even an excess of the latter. Generally, 2—4% resin by weight of the sand is adequate, although slightly higher amounts, say up to 5% may be employed with some sands which include some absorptive clay content.

In the hot process, the liquid novolak resin, or the solid novolak resin in either solid or molten form is added to the sand to be coated in a suitable mixing device, together with hexamethylenetetramine and the unctuous additive. These are heated by employing a vessel having a steam jacket, or by introducing heated air or by merely employing adequately preheated sand. The heat is employed to aid or to maintain the resin in liquid condition for coating the sand grains and for permitting partial reaction of the resin with the hexamethylenetetramine. The heating is terminated and the materials cooled by adding cooling water or by loss of heat of the originally preheated sand when the melting point of the resin on the sand is advanced to at least 80° C. and up to 102° C. in the case of the liquid resin, and up to 115° C. in the case of the solid resin. At this point the resin may be said to be in a potentially thermosetting condition since all of the hexamethylenetetramine for thermosetting purpose on further heating is present. The unctuous material, on cooling, largely precipitates out of the hot resin and forms a thin layer on the resin surface and a uniform coating.

In the cold process, the liquid one-stage resin, or the liquid novolak resin together with hexamethylenetetramine, or the solid novolak resin dissolved in a solvent together

with hexamethylenetetramine, is mixed with sand in a suitable mixing vessel, without added heat. The unctuous additive is further added in one or more increments during mixing. Due to the absence of heat, the one-stage resin does not advance, and with the novolak resins there is no rapid reaction between the resin and the hexamethylenetetramine, although some appears to take place to a limited extent. After several minutes of mixing, during which time cool air may be blown through the mixing vessel to facilitate removal of volatiles, the mass is reduced to a free-flowing discrete particle condition composed of particles of sand each individually coated with a potentially thermosetting resin composition enveloped by a film of solid, non-tacky, unctuous material.

In all cases the employment of these waxy or unctuous additives results in an increase of 100 pounds or more per square inch in tensile strength in standard tensile briquets prepared from the resin coated sand as compared to a similar test from resin coated sand which did not include the additive.

The following examples are illustrative of the present invention:

EXAMPLE I

4540 grams of washed foundry sand were heated to 285—290° C. and placed in an open eighteen-inch Simpson laboratory muller. To this were added 125 grams of normally liquid novolak resin, of the kind previously described, and the mixture mulled for fifty seconds. Then 12 grams of hexamethylenetetramine and 2 grams of "Acrawax C" were added and the mulling continued. After about four minutes the resin coated sand had cooled, by transfer of heat through the metal of the mixer and to the atmosphere, to below its now modified melting point, and the doughy mass began to break up. Further mixing for five minutes broke up the clumps of coated sand to a free-flowing material which was then ready for use. The melting point of the resin on the sand was 95° C. as compared to 88° C. when the wax was omitted. The tensile strength of a test briquet prepared therefrom was 512 pounds per square inch as compared to 305 pounds per square inch when the wax was omitted.

EXAMPLE II

200 pounds of washed and dried 60-mesh silica sand were placed into a Beardsley-piper "Speedmuller" mixing vessel, together with 4 pounds of liquid novolak resin formed from 0.7 mols of formaldehyde per mol of phenol and dehydrated to a 70% solids content, and 0.48 pounds of hexamethylenetetramine containing 5% talc. These were mixed at room temperature for three minutes with cold air blown through the mixing vessel to facilitate removal of volatiles. At this time the mass started to break up and 0.28 pounds of "Acrawax C" was added and mixing continued for two more minutes and the product discharged as a free-flowing sand with some small lumps which were removed by screening. The melting point of the coating on the sand was 80° C. Test briquets formed by blowing at a pressure of 25 pounds per square inch exhibited a tensile strength, after cure of the resin, of 360 pounds per square inch.

The product resulting from the use of the unctuous additives was of an enhanced free-flowing nature and of a silky texture, with the resin coating on the sand enveloped by a thin layer of unctuous material. The muller ran extremely quietly and smoothly and the surfaces of the vessel remained clean. The test briquets were of about 13% increased density over the control. Shell molds prepared from the resin coated sand including the unctuous material envelope, employing a clean pattern surface, exhibited substantially complete absence of "fall off" and only minor edge "peelback," and did not require any other lubricant or parting agent. The indicated improvements in tensile strength were a marked advantage.

What we claim is:—

1. Free-flowing, storage-stable, dustless, non-tacky particles of sand individually coated with thermosetting resin material and a solid outermost coating of waxy material.

2. The product of claim 1 wherein the resin is a one-stage thermosetting phenol-formaldehyde resin.

3. The product of claim 1 wherein the resin is a two-stage potentially thermosetting resin composed of normally thermoplastic phenol-formaldehyde resin including and partially reacted with hexamethylenetetramine.

4. A product according to claim 1 characterized by being particularly adapted for use as a molding sand for the production of shell molds, the waxy material acting as a pattern lubricant and giving the molds increased tensile strength.

5. The product of claim 1 wherein each sand particle is coated with and completely enveloped by a blended dual-layer hard film which is non-tacky at normal room temperature composed of an inner film layer of heat hardenable resin and an outer film layer of a wax or wax-like material.

6. In a method of forming a substantially free-flowing mass of non-tacky sand grains, wherein each particle of sand is coated with an adherent layer of thermosetting resin by intimately mixing sand with heat-hardenable phenol-formaldehyde resin in liquid condition, the improvement which comprises including a normally solid waxy material in the mixture to additionally coat the sand grains therewith.

7. The method of claim 6 wherein the waxy material is in the amount of 0.3 to 15% by weight of the sand and is added in the form of a powder or paste or solution.

8. The method of claim 6 wherein the resin

and the waxy material are placed or retained in the liquid condition by heat and then cooled to solidification and limit advancement of the resin to retain it in a thermosetting condition.

9. The method of claim 6 wherein the process is conducted without heating and the resin employed is dissolved in a solvent or is one which is normally liquid at room temperature.

10. The process of claim 6 wherein the waxy material, in whole or in part, is added before or during the mixing.

11. Coated, free-flowing particles of sand as claimed in claim 1 and substantially as herein described.

12. A method of forming free-flowing particles of sand coated successively with thermosetting resin and waxy material substantially as herein described.

STEVENS, LANGNER, PARRY & ROLLINSON,
Chartered Patent Agents,
Agents for the Applicants.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1956.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.